EXHIBIT 2

REDACTED

HIGHLY CONFIDENTIAL

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
SHERMAN DIVISION

The State of Texas, et al., Plaintiffs; v. **Google LLC,** Defendant.	Case No. 4:20-cv-00957 Hon. Sean D. Jordan Special Master: David T. Moran

EXPERT REPORT OF DR. JOHN CHANDLER, Ph.D.

JUNE 7, 2024

DR. JOHN CHANDLER, Ph.D.

25. The display advertising marketplace trades in the attention of individuals and the information that their online activities reveal. Publishers, like website owners who sell space for ads, want to amass the largest and most valuable audiences so they can earn the highest rates from advertisers.[12] Advertisers, in turn, are able to draw on immense troves of dynamic information about the habits and traits of the audiences they are buying and advertising to. With this information, and with the increasingly sophisticated technologies that both advertisers and publishers develop to access and analyze user information, marketers fine-tune their strategies in order to increase profits.

26. The contemporary display advertising ecosystem is a dynamic, technologically driven, and highly profitable market. To understand how a company like Google rose to prominence in this space, it is helpful to understand how the current ecosystem of display advertising, and the advertising technology (ad tech) industry that supports it, evolved from the early days of digital advertising.

27. As I will elucidate below, advertising is viewed as comprising three key components that I will refer to as the "who, what, and where" of advertising.[13] The "who" component is the audience[14] to which the advertisement is being shown. In the context of digital marketing, advertisers typically have an incomplete picture of the person who receives an advertisement. The amount of data and type of data available for an individual is a key, defining characteristic of advertising. The "what" of advertising is the ad content, typically called the "creative."[15] There are hundreds of creative formats online, but the most common are ads that would be recognizable to any regular user of the web: a piece of video, a social media post, or a display banner. The "where" of advertising refers to the context within which the ad is viewed. This context influences the recipient of the ad, but also can radically change the information that advertisers have. For instance, we unfortunately know a great deal about someone searching for "mesothelioma"[16] or "long-term asbestos exposure." Similarly, social media marketers may leverage highly predictive information about how someone's friends responded to content on the site.

---

[12] There may be others.

[13] Giombi, K., Viator, C., Hoover, J., Tzeng, J., Sullivan, H., Donogue, A., Southwell, B., and Kahwati, L., "The impact of interactive advertising on consumer engagement, recall, and understanding: A scoping systematic review for informing regulatory science." *PLOS ONE* vol. 2, no. 17. 2022.

[14] Walmsley, B. "Understanding Audiences: A Critical Review of Audience Research." *Audience Engagement in the Performing Arts*. 2019. pgs. 25-62; *See also,* Pascucci, F., Savelli, E., Gistri, G., "How digital technologies reshape marketing: evidence from a qualitative investigation" *Italian Journal of Marketing*. 2023. Pgs. 1-32.

[15] Altamira, M., Putri, K., Samdura, R. "The Role of Creative Content in Digital Marketing Strategies in Educational Institution social media (Case Study: Instagram of Vocational Education Program, Universitas Indonesia)." *Proceedings 2022* vol. 83, no. 1. 2023. pgs. 1-12.

[16] Digital Commerce. "The most expensive keywords in paid search, by cost per click and spend" (August 6, 2015). Accessed on June 3, 2024. https://www.digitalcommerce360.com/2015/08/06/most-expensive-keywords-paid-search-cpc-and-spend/.

3) Web commentary by industry leaders, like John Battelle, which helps to illustrate experiences that I share with other practitioners.

4) Informational websites, like online references or the site of the Interactive Advertising Bureau, which provide definitional support for many of the industry concepts germane here and help explain their evolution. Statista, for example, aggregates data and conducts its own research, and has been providing reliable data to practitioners since 2007.

5) Academic papers. Since marketing moves quickly, academic sources cannot always address current iterations of practice. Nevertheless, where academic resources are available for my research and relevant, I turn to these for support.

C. Key Definitions

31. When marketers strategize to place display ads, they take account of many of the following concepts:

1) **Impressions.** An impression is the unit of measurement of digital advertising and represents a single instance of a particular ad being shown.[17] One can think of an impression as the viewing of an advertisement. In broadcast TV, there are as many impressions of a single spot as there are televisions turned to that channel when the spot airs. Out-of-home impressions are determined by the number of people passing by the ad at an angle which allows them to see the content. On the web, impressions are views of ads, though there are areas of dispute, such as whether an ad could have actually been seen.[18]

   Impressions help marketers measure their advertising. Advertisers also take stock of locations where their advertisements are appearing (on which platforms, sites, geographic locations, etc.).[19]

2) **Reach.** The number of unique people who come into contact with specific marketing content. Reach helps marketers know how well they are saturating an audience with advertising. When consumers engage with advertising, they provide a new, powerful set of data points. Digital marketing practitioners use the metric reach, but typically are actually

[17] The IAB has a technical definition that takes into account things like bot activity, error codes, and when the impression happens. *See,* IAB. "Glossary of Terminology" (undated). Accessed on June 5, 2024. https://www.iab.com/insights/glossary-of-terminology/.
[18] Google Ad Manager Help. "Overview of Viewability and Active View Next: How Active View metrics are calculated" (undated). Accessed on June 4, 2024. https://support.google.com/admanager/answer/4524488?hl=en.
[19] When advertising content is shared through online communication and social media, new impressions are generated. Impressions are the currency of most digital advertising.

6) **Direct Buying:** Direct Buying in digital advertising refers to the process where advertisers purchase ad inventory directly from publishers or media owners. This approach often involves negotiations and agreements on pricing, placements, and campaign specifics, leading to guaranteed ad placements on selected websites or platforms.

7) **Indirect Buying:** Indirect Buying is the process where advertisers purchase ad inventory through intermediaries such as ad networks, ad exchanges, or demand-side platforms (DSPs). This method allows advertisers to reach a broader audience across multiple publishers, often using automated systems to bid for ad placements in real-time.

8) **Walled Gardens:** Walled Gardens in digital advertising refer to closed ecosystems where the platform owner controls the ad inventory and data. Prominent examples include Google, Facebook, and Amazon. These platforms provide advertisers with access to their extensive user data and inventory but restrict data sharing outside their ecosystem, creating a "walled" environment. Display advertising outside walled gardens are often referred to as "open web display advertising."

9) **CPM:** CPM, or Cost Per Mille, is a pricing model in digital advertising where advertisers pay a set fee for every thousand impressions (views) of their ad.

10) **CTR:** CTR, or Click-Through Rate, is a metric that measures the percentage of users who click on an ad after seeing it. It is calculated by dividing the number of clicks by the number of impressions and is expressed as a percentage. CTR is an indicator of an ad's effectiveness and engagement.

11) **Website Action:** In digital advertising, a Website Action typically refers to a specific user interaction or behavior that an advertiser aims to track and measure, such as a click, form submission, purchase, or download. Website Actions are critical for evaluating the success of an ad campaign. When I am comparing Website Actions to Conversions, I will typically refer to them as simple "Actions".

12) **Conversion:** A Conversion occurs when a user completes a desired Website Action after viewing interacting with an ad. Conversions are used to measure the effectiveness of advertising campaigns in achieving their objectives.

13) **Last-Ad Attribution:** Last-Ad Attribution is a model in digital marketing that assigns 100% of the credit for a conversion to the last ad that a user interacted with before making a purchase or completing a desired action. This model assumes that the final touchpoint is the primary

driver of the conversion, ignoring the influence of earlier interactions. Last-Ad Attribution is simple to implement and analyze, but it may not fully capture the contribution of other marketing efforts throughout the customer journey.

14) **Return on Ad Spend (ROAS) and Return on Investment (ROI):** ROAS measures the revenue generated for every dollar spent on advertising. It is calculated by dividing the total revenue from ad campaigns by the total ad spend. ROAS helps advertisers evaluate the direct financial impact of their ad investments. ROI is a broader financial metric that measures the overall profitability of an investment, including advertising. It is calculated by dividing the net profit by the total investment cost and is expressed as a percentage. ROI provides a comprehensive view of the financial return from marketing efforts. For the purposes of this report these terms will be used interchangeably since the investment in question is advertising spend.

15) **Programmatic Guaranteed:** Programmatic Guaranteed is a form of programmatic advertising where ad inventory is reserved in advance at a fixed price. Unlike real-time bidding, this approach guarantees ad placements on specific sites or platforms, combining the automation and efficiency of programmatic buying with the assurance of direct deals.

16) **Open Auction:** An Open Auction is a real-time bidding process where multiple advertisers bid for ad inventory in a public auction. Ad exchanges facilitate these auctions, and the highest bidder wins the ad placement. This method allows for broad competition and leads to higher ad prices.

17) **Private Auction:** A Private Auction is similar to an open auction but is invitation-only. Publishers invite selected advertisers to participate in the bidding process, often giving them priority access to premium ad inventory. This approach maintains competition while offering more control to the publisher over who bids on their inventory.

18) **Header Bidding:** Header Bidding is a programmatic advertising technique where multiple ad exchanges can simultaneously bid on ad inventory before the publisher's ad server makes a call. This method increases competition, potentially leading to higher revenue for publishers by allowing them to receive bids from various sources at once.

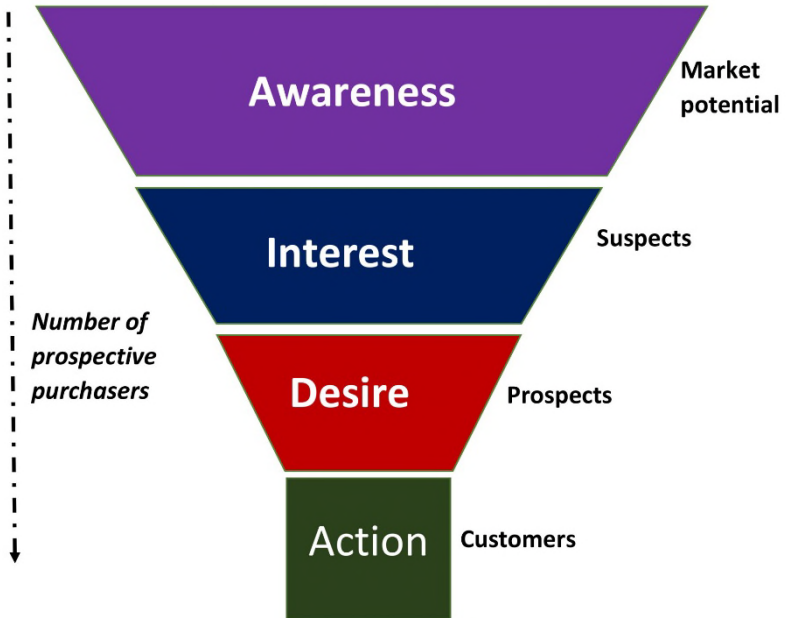
19) **Waterfall:** The Waterfall model in digital advertising is a sequential ad serving process where inventory is offered to one buyer at a time. If the inventory is not sold, it is passed down to the next network in line, and so on. This method can be less efficient than header bidding due to its

linear nature, potentially missing higher bids from lower-priority buyers.

D. The Marketing Funnel

32. One of the foundational conceptual structures in marketing is called the marketing funnel, which helps explain the stages consumers move through as they learn about products for the first time and later commit to them with purchases or loyalty. Also known as the purchasing funnel, or the advertising funnel, the marketing funnel is a classic framework that has been around for decades, first appearing in 1898. It therefore applies both to traditional marketing and digital marketing.

33. In one of its original forms, the marketing funnel, outlines four stages of marketing: awareness, interest, desire, and action (AIDA). Each of these sections describes a stage in the process of appealing to consumers at various stages of the customer journey that leads from product awareness to a purchase or commitment to a product or brand. The framework of the funnel helps marketers understand the different kinds of ads that are appropriate to consumers at different stages of product engagement. Below is an accurate, sample diagram of this funnel:[22]



34. Customers do not necessarily move through all the stages of the advertising funnel in a linear or sequential way, and the funnel has evolved considerably since its original formulation to adapt to different kinds of markets and consumers. In general, the funnel helps convey and distinguish key practices in advertising campaigns and how they look in both traditional and digital media.

[22] Wikimedia Commons. "The Purchase Funnel" (undated). Accessed on June 3, 2024. https://commons.wikimedia.org/w/index.php?curid=53843096.

94. **Opinion No. 3:** A substantial portion of display advertisers purchase their display advertising space through a programmatic auction process, rather than or in addition to guaranteed direct contracts with publishers. Display advertisers use programmatic buying for a variety of reasons, though the primary reason is efficiency. Via programmatic display, advertisers can: (a) increase the number and variety of sites on which their advertisements appear; (b) have greater flexibility to modify or change the types of ads, publishers, and targeted viewers of their ads; and (c) reduce the costs of media buying.

95. **Opinion No. 4:** A substantial portion of publishers offer some portion of their advertising inventory for sale through programmatic auctions. Publishers use programmatic selling for a variety of reasons, but the primary one is yield maximization. Via programmatic selling publishers can: (a) have access to a much wider pool of advertisers, increasing the demand for their advertising space; (b) reduce or eliminate the need for and cost of a direct display ad sales staff; (c) provide a sales channel for remnant display space inventory not sold directly; and (d) maximize the portion of available inventory that is sold. This inventory is subjected to a bidding process and sold to the highest bidding advertiser or to a third party acting on the advertiser's behalf.

96. **Opinion No. 5:** There are a number of types of display auctions, including those with one or more of the following characteristics or structures: (a) first price versus second price; (b) real-time versus one participant having last-look; (c) header bidding versus Google's Open Bidding; and (d) waterfall versus multi-tier versus single-tier. Each of those characteristics is generally understood in the digital advertising and ad tech industries as having a specific algorithmic structure.

B. Introduction

97. In 2000, the vast majority of display ad inventory was purchased directly from publishers through human-negotiated deals. Programmatic ad buying, which leverages software and algorithms to automate the process, existed but was still nascent, with only 1% of online advertising spend.[45]

98. The mid-to-late 2000s saw the emergence of ad networks and exchanges that opened up programmatic channels. DSPs gave advertisers the ability to buy across multiple sources in an automated fashion. The advent of real-time bidding (RTB) ad exchanges allowed advertisers to buy impressions through instantaneous auctions. These technological developments set the stage for programmatic' s growth.

99. Several factors then coalesced to drive rapid adoption of programmatic display buying over the next decade. Publishers made more of their display inventory

[45] [45] Choi, H., Melay, C., Balseiro, S. R., & Leary, A. "Online Display Advertising Markets: A Literature Review and Future Directions." *Information Systems Research* vol.31, no. 2. 2020. pgs. iii-vii, 297-652, C2.

available through programmatic pipes, providing greater supply. Advertisers were attracted by programmatic' s efficiency in reaching targeted audiences across the web at scale. The expansion into video, mobile, and over-the-top (OTT) television inventory transacted programmatically opened new frontiers. Programmatic display ad spending in the U.S. grew from 10% of display in 2010 to 72% of display by 2021[46], representing a large majority of total display ad spending.

100. According to Statista, programmatic display ad spending in the U.S. grew from $50 billion in 2018 to a projected $168 billion by 2024.[47]

101. The forces propelling the rise of programmatic include its ability to combine enhanced audience targeting through data, the efficiency and cost benefits of automation, greater inventory access, and precise attribution measurement. As brands allocated more digital spend programmatically, the channel hit a tipping point and became the new standard for display advertising.

102. The evolution of auctions in digital advertising is a tale of increasing sophistication and technological advancement, reflecting the industry's response to the need for more efficient and effective ad buying processes. Initially, digital ad buying relied heavily on the "waterfall" or "daisy chain" auction model, where ad inventory was offered to buyers sequentially. In this model, if the first buyer in the sequence did not purchase the inventory, it would cascade down to the next buyer, and so forth. This method often resulted in suboptimal fill rates and revenue, as premium inventory might not be sold at its true market value.

103. As technology advanced, the industry moved towards more sophisticated multi-tier auction environments. These setups allowed multiple buyers to bid on the same inventory simultaneously, but in different tiers, based on their perceived priority. This method aimed to increase the chances of inventory being sold at a higher price but could still leave room for inefficiencies, as not all buyers were given equal opportunity at the outset.

104. The shift to single-tier, real-time bidding (RTB) auctions marked a significant evolution. In RTB, all potential buyers bid on inventory in a single auction. This shift, which began in the late 2000s, was driven by advancements in software and technology that enabled the handling of vast amounts of bid data at incredible speeds, ensuring that inventory could be sold at its maximum potential value in a fair and efficient manner.

105. This evolution from waterfall to RTB auctions can be attributed to the increasing complexity of software solutions in the programmatic space, which have

[46] *Id.*
[47] Insider Intelligence. "Programmatic digital display advertising spending in the United States from 2018 to 2024 (in billion U.S. dollars)." Chart. February 28, 2023. Statista. Accessed June 06, 2024. https://www.statista.com/statistics/278727/programmatic-display-ad-spend-in-the-us/.

allowed for more granular data analysis and real-time decision-making. These technological advancements have fundamentally transformed how ad inventory is bought and sold, optimizing revenue for publishers and efficiency for advertisers.

C. Differentiating Programmatic Auctions from Other Forms of Ad Sales

106. In digital advertising, understanding the distinctions between different methods of ad sales is crucial. Programmatic advertising, which includes real-time bidding (RTB) and programmatic direct deals, leverages automated systems and algorithms to buy and sell ad inventory. This method contrasts sharply with traditional, non-programmatic sales approaches that often involve manual negotiations and direct relationships between advertisers and publishers.

107. To understand the different ways that ad sales take place, it is useful to break down ad sales into a 2x2 grid, categorizing them into direct vs. indirect sales and programmatic vs. non-programmatic methods. The types of advertising that fall into each category is summarized in the following table:

	Direct Sales	Indirect Sales
Programmatic	Automated transactions for guaranteed ad placements. Typically, large advertisers and premium publishers.	Real-time bidding (RTB) for ad impressions through ad exchanges. DSPs and SSPs facilitating real-time auctions.
Non-Programmatic	Manual transactions involving direct negotiations and contracts. High-touch sales teams from both advertisers (e.g., luxury brands) and publishers (e.g., magazine websites) engaging in bespoke agreements.	Aggregation and selling of inventory via ad networks. Ad networks aggregating inventory from small publishers and selling to advertisers seeking broader reach.

108. Direct sales typically involve guaranteed ad placements through direct agreements between advertisers and publishers, while indirect sales use intermediaries like DSPs, SSPs, ad networks, and exchanges. Within these categories, programmatic sales introduce automation and real-time processing, enhancing efficiency and targeting precision, whereas non-programmatic sales rely on manual processes and predefined agreements. This section will explore these differences, highlighting how each method operates and the implications for marketers.

109. Ad sales can be broadly categorized into direct and indirect sales, each with programmatic and non-programmatic methods. The difference lies in the process used to execute the transaction for the inventory.

110. Direct sales involve direct negotiations between advertisers and publishers, ensuring premium placements and guaranteed impressions. Traditional direct sales rely on manual processes, contracts, and personalized agreements, emphasizing relationship-based transactions. Conversely, programmatic direct, or automated guaranteed, uses automated systems to facilitate these direct deals, maintaining the pre-negotiated terms and guaranteed impressions but adding the efficiency of automation.

111. Indirect sales focus on selling ad inventory through intermediaries, such as ad networks or exchanges, typically for remnant inventory. Remnant inventory denotes ad impressions that have not been sold via guaranteed deals. Traditional indirect sales involve ad networks that aggregate inventory from multiple publishers, using less automation and often requiring human negotiation. Programmatic indirect sales, however, leverage real-time bidding (RTB) through ad exchanges, employing algorithms and automated systems to buy and sell ad inventory in real-time based on instantaneous auctions. This method significantly enhances efficiency and targeting precision.

112. If we turn our attention to programmatic versus non-programmatic advertising, we see a split primarily along the lines of efficiency.

113. Programmatic advertising revolutionizes ad sales by using automated systems and algorithms to facilitate buying and selling. Real-time bidding (RTB) is a key component, allowing advertisers to bid on individual ad impressions in real-time auctions, enhancing flexibility and efficiency. Programmatic direct combines automation with pre-negotiated deals, ensuring guaranteed impressions with the ease of automated processing.

114. Non-programmatic advertising, on the other hand, relies on manual transactions and traditional ad networks. Manual transactions involve human negotiation, insertion orders, and personalized agreements, making the process slower and more labor-intensive. Ad networks aggregate inventory from various publishers, but the process lacks the real-time capabilities of programmatic methods. This approach often results in less precise targeting and reduced efficiency compared to programmatic advertising.

D. The Advantages and Basic Rules of Programmatic Auctions

115. While ad exchanges are the marketplace where advertisers and publishers come together, and with the help of their ad buying tools and supply side platforms, buy and sell ads, the auction is the central activity through which ads are bought and sold on exchanges.

116. The structure and rules of auctions are important to understand to grasp industry norms in the realm of exchanges and in the ad tech industry in general. The following explains the elements and basic workings of an ad auction.

117. Ad exchanges are where advertisers come together with publishers, with advertisers buying and publishers selling ad impressions through real-time auctions. Publishers use publisher ad servers to facilitate the selling of their inventory. Section VII explains the structure of the ad tech ecosystem in detail.

118. For publishers, being able to make available general and remnant inventory to multiple bidders to hundreds of potential buyers present significant advantages. The auction environment can also allow publishers to earn higher bids for inventory that might otherwise be sold to a narrower group of advertisers.

119. For advertisers, the auction environment makes available advertising space across hundreds of platforms that can be bought and served almost instantaneously, so it makes the greatest possible efficiency possible. Because of the broad range of inventory available, the auction environment can also give advertisers access to inventory that meets their optimization criteria at the lowest cost. [redacted]

[redacted].[48]

120. Given the benefits to buyers and sellers, it is not surprising that since the first ad auctions in 2007 and 2008, the inventory sold on ad exchanges has increased dramatically. So too has the number of entities buying and selling ads. At present, billions of transactions in advertising sales occur each day.[49]

121. One of the ways that publishers are able to provide more and more of their inventory to advertisers is through header bidding. This is when publishers offer their inventory to many different advertising exchanges before making calls to their ad servers. Header bidding is described lucidly by the site clearcode.cc, who offer an explanation that matches my own understanding, as a kind of advanced bidding "that enables publishers to simultaneously collect multiple bids from a number of demand sources (not only from their ad server) on all of their ad inventory prior to a

[48] Deposition of [redacted].
[49] [redacted] Usage of Google's exchange, AdX, has grown as well. *See* GOOG-AT-MDL-000016711 at –735.

125. It is easy to understand those worries. Since Open Bidding is conducted on the auction server-side, Google maintains greater control over the bidding process and can potentially prioritize its own exchange over others. Additionally, Open Bidding requires publishers to use Google's ad server, further entrenching Google's dominance and limiting the opportunities for independent ad tech companies to compete. While Open Bidding initially offered certain technical benefits, such as reduced latency and simplified implementation, it raised and continues to raise concerns about transparency and fair competition in the programmatic advertising market.

126. [redacted] Within Google, [redacted]

127. [redacted]

128. At the auction stage, there are two main kinds: first price and second price. In a first price auction, the highest bidder wins the ad inventory up for bid.

129. In a second price auction, the winning bid pays $0.01 more than the second-highest bid, as in this image:[61]

---

[56] The titles in tech can be opaque. This title refers to a [redacted]

[57] HB Wrappers, or Header Bidding Wrappers, are pieces of software used by publishers to manage multiple header bidding partners efficiently. They provide a framework for running header bidding auctions, where multiple demand sources bid on the same ad inventory simultaneously.

[58] [redacted] These companies make up the short list of companies who have the ads expertise and the software resources to build enterprise-class HB Wrappers. With this sort of tool, publishers could tap into a diverse range of demand sources, increasing the competition for their ad space and potentially driving up their ad revenues. This migration from Google to a competitor is the threat.

[59] GOOG-TEX-00090151. [redacted]

[60] GOOG-TEX-00110540. [redacted]

[61] Kevel. "What are Ad Auctions? The Definitive Guide" (May 16, 2024). Accessed on June 4, 2024. https://www.kevel.com/blog/ad-auctions.

130. Second-price auctions with sealed bids, may seem strange, but they have unique benefits for advertisers and publishers alike.[62] The key benefit is that, according to auction theory, sealed-bid second-price auctions allow bidders to bid the true value of an impression. This saves advertisers time and effort, since they do not need to try to game the auction by estimating competitive bids, uncover dynamic price floors, engage in "bid shading," or model auction dynamics.

131. Since advertisers can bid their true estimated worth of the impression, publishers benefit as well. They are likely to enjoy greater revenue since advertisers are freed from practices like bid shading. The ease and simplicity of the method can encourage additional participation by advertisers, ultimately driving up the value of the inventory.

132. There are two particular flavors of auctions that are germane to my report: real-time bidding (RTB) auctions and auctions where someone has a "last look". As mentioned above, RTB auctions are those were all bids are "opened" at the same time and a winner is determined. An auction with a last-look participant operates differently.

133. "Last look" refers to a scenario where one participant is given the final opportunity to bid on an ad impression after all other bids have been submitted. This privileged position allows the entity with the "last look" to see all the competing bids and then decide whether to outbid the highest bid or let it stand.

134. The "last look" advantage is significant for several reasons. First, it provides a competitive edge, enabling the privileged participant to always submit the highest bid and consistently win the auction for valuable ad impressions. This

[62] Vickrey, W. (1961). "Counterspeculation, Auctions, and Competitive Sealed Tenders." Journal of Finance, 16, 123-145. Source, 5Vickrey, W. "Counterspeculation, Auctions, And Competitive Sealed Tenders" *The Journal of Finance* vol. 16. no. 1. March 1961. https://onlinelibrary.wiley.com/doi/10.1111/j.1540-6261.1961.tb02789.x.

competitive edge leads to a higher win rate compared to other bidders who do not have the opportunity to see competing bids before submitting their own.

135. Second, with visibility of all other bids, the "last look" participant can strategically bid just above the highest competing bid, minimizing their costs while still securing the impression. This optimized bidding allows them to maximize their return on investment by paying only slightly more than the next highest bidder, rather than potentially overbidding in a blind auction.

136. Third, the "last look" privilege provides valuable insights into competitors' bidding strategies and market prices. This data can be used to refine their own bidding algorithms, better understand market dynamics, and improve future bidding decisions.

137. Lastly, entities with the "last look" can exert significant influence over the market by consistently winning key ad impressions. This leads to a consolidation of market power, making it more difficult for smaller or less privileged competitors to compete effectively.

138. "Last look" raises concerns about fairness and competition in the programmatic advertising ecosystem. The ability to consistently outbid competitors creates an uneven playing field, where the privileged participant dominates auctions and limit opportunities for other bidders. This leads to reduced competition, higher costs for advertisers, and potentially lower revenues for publishers who may not receive the full value of their ad inventory due to the strategic underbidding facilitated by the "last look" advantage.

139. Once an auction takes place, almost instantaneously, the ad server will place an advertisement automatically in the location and with the specifications that the advertiser has purchased in buying the ad. It is helpful to remember that once the auction takes place and the ad is being served, not just the publisher and advertiser are involved with the transaction, but now also the consumer.

VII. The Ad Tech Ecosystem

A. Opinion 6

140. The programmatic purchase and sale of display advertising space involves a complex ecosystem of intermediary "ad tech" platforms and tools that streamline and optimize the process. These intermediaries play crucial roles in managing inventory, serving ads, and facilitating transactions between buyers and sellers. This system includes several key components: a publisher inventory management system, a publisher ad server, an advertising exchange, an advertiser ad server, and an advertiser buying tool. Each of these elements works in concert to ensure the efficient and effective delivery of digital ads across various platforms. In light of my discussion of the ad tech ecosystem, I offer the following opinion:

141. **Opinion No. 6:** The programmatic purchase and sale of display advertising space is effectuated through services provided by intermediary "ad tech" platforms and tools, which generally include, but are not always limited to: (a) a publisher inventory management system; (b) a publisher ad server; (c) a publisher selling tool; (d) an advertising exchange; (e) an advertiser ad server; and (f) an advertiser buying tool.

B. Introduction

142. As mentioned in the introduction to digital marketing, advertising comprises three components: placements, creatives, and audiences. These components can be thought of in the following way: the creative content of the ad, also known as the ad creative (the "what"), the placement of the ad (the "where"), and the audience or individual to whom the ad is served (the "who"). This section is devoted to ad tech, which is the "how" of digital advertising.

143. In general, one can think of the ad tech ecosystem as the complex system of entities that facilitate digital advertising. At its most basic level, this system can be understood as a system driven by supply and demand. On the supply side, there are publishers, like websites with space where ads can be displayed. On the demand side, there are advertisers who seek to display their ads to a specific audience. In order to scale up and facilitate the transactions between the two sides, a broader set of entities have emerged, which includes supply side platforms (SSPs) which help aggregate advertising inventory, demand side platforms (DSPs) which help aggregate and place advertising inventory, and exchanges which facilitate the exchange between the two sides. Each entity in this ecosystem faces challenges unique to the task that they aim to complete. Following the path of each entity through this system, it is clearer how these challenges become more or less difficult to solve based on the actions of other entities in the system.

144. As discussed below, there are many different entities in ad tech. These entities, however, have not remained fixed over time. One reason for this lack of fixity is product extension. For instance, at one point publisher ad servers, publisher inventory management companies, yield optimization companies, and SSPs were highly distinct market categories. I discuss the ad serving process below. Inventory management systems once were stand-alone systems that helped publishers forecast their upcoming inventory, keep track of what inventory had been sold, and make sure the publisher met its contracted delivery targets. Yield optimization companies provided services to help publishers find the optimal price for their inventory.

145. For instance, Microsoft acquired AdECN[63], an ad exchange platform, with the goal of bolstering its yield optimization offerings. Similarly, Google acquired

[63] Microsoft. "Microsoft to Acquire AdECN, Inc" (July 26, 2007). Accessed on June 4, 2024. https://news.microsoft.com/2007/07/26/microsoft-to-acquire-adecn-inc/.

AdMeld in December of 2011[64] to improve this facet of the business. The distinction between these types of companies have evaporated in the last 15 or so years, with all of these products and product features now being subsumed under the category of publisher ad servers. In the sections below, I explain the historical origins of the tools and point out the contraction in roles that have occurred over time.

146. It may be helpful to imagine the process of ad-serving as an interaction between three computers. One computer belongs to the user and holds the user's web browser, which will ultimately display the rendered webpage with any ads on that page. The second computer is the publisher's web server. The publisher has a website with space for ads. The user pings the publisher's web server. Then the publisher's web server goes back and forth with the user and a third computer, the advertiser's ad server. The ad server has all of the ad creative files and impressions are counted.[65] Eventually the publisher and ad servers leave with data, and the user sees an ad on the website. This happens in seconds.

147. Outlined below is a more detailed, step by step account of the process[66]:

1) User requests a webpage: Imagine you're on the Internet, and you want to visit a website. You either type the website's address into your browser or click on a link.

2) Publisher's server receives the request and prepares to serve the webpage: When you want to see a webpage, your request goes to a big computer called a server that holds that webpage. This server gets ready to send you the webpage you asked for.

3) Publisher's server sends an ad request along with user data to the ad server: Along with the webpage you want to see, the server also sends a message to another computer called an ad server. This message includes some information about you, like your location or interests, to help show you ads that you might be interested in.

4) Ad server receives the request and processes it, selecting suitable ads: The Ad Server gets the message and decides which ads would be best to show you. It looks at things like what you might like and what ads are available.

---

[64] Google Official Blog. "Take a walk on the sell-side" (December 2, 2011). Accessed on June 7, 2024. https://googleblog.blogspot.com/2011/12/take-walk-on-sell-side.html*See also,* Hong, A., Bhattacharyya, D., & Geis, G. (2012). "The Role of M&A in Market Convergence: Amazon, Apple, Google and Microsoft." *Proceedings of 18th International Business Research Conference 2012*. 2012.
[65] Interactive Audience Measurement. "Interactive Audience Measurement and Advertising Campaign Reporting and Audit Guidelines" (September 2004). Accessed on June 4, 2024.
[66] ClearCode. "Ad Serving" (undated). Accessed on June 6, 2024. https://adtechbook.clearcode.cc/ad-serving/.

5) Ad selection process: The ad server picks out the ads that it thinks you'll find interesting from all the options it has.

6) Ad server requests advertiser's ad tag: Once it knows which ads to show, the server asks the companies that made those ads to send them over.

7) Advertiser's server sends the ad tag: The companies that made the ads get the message and send over the details about their ads, like how they should look and where they should go.

8) Ad creative request: The ad server then asks for the actual images or videos that make up the ads from the companies.

9) Advertiser's server sends the ad creative: The companies send over the pictures or videos, and the ad server gets them ready to show to you.

10) Advertiser's server redirects to a 1x1 pixel: After showing you the ad, the companies may send a little invisible pixel to your browser. It's like a code that helps them know if you saw the ad.

11) 1x1 Pixel Request: Your browser gets the little pixel, and it tells the companies that you saw the ad.

12) Advertiser's server records impression and counts it: The companies know that you saw their ad because of the little pixel, and they keep track of it.

13) Advertiser's ad renders: Finally, the ad shows up on the webpage you wanted to see. It might be a picture or a video, but either way, it's there for you to look at. This is one of the main ways that ads end up on the websites you visit.

ESPN, for example, which is a major publisher of ads. Because of its extremely large user base, ESPN is often a highly attractive publisher for potential advertisers.

150. In addition to amassing audience attention, publishers are also interested in acquiring information about audience members so that inventory can be repackaged, typically using data. This repackaging allows publishers to increase the value of their inventory, since advertisers can use this information to target their advertising campaigns at particular kinds of audiences. Again, a platform like ESPN not only commands a large audience, but it also possesses extensive and highly refined data about the media consumption habits of its users. It therefore can offer advertisers not only large audiences, but also information about individual demographics, and audience patterns. In so doing, a publisher like ESPN can help advertisers target their audiences more effectively. For instance, ESPN could sell audience segments such as "people who follow two or more Texas professional sports teams" or "people whose favorite NBA team has just won a game" or "avid soccer fans."

151. Two additional characteristics of audiences that publishers highlight to attract advertisers are concentration and value. Some advertisers seek audiences that are focused on specific products or services. Consider a website like Investopedia, for example, which attracts consumers interested in learning about investing. This kind of audience is focused on a specific kind of product. So, it could be said that it is a highly concentrated audience. This audience could also be seen as potentially high value, since consumers looking at investment sites often have more expendable income, and so may be more likely to consume products advertised on that site.

152. For publishers to provide ad space to advertisers, they rely on their publisher ad server. At one point these were third-party tools that helped manage the advertising operations, or "ad ops," of the business. Two key technologies, inventory management systems and ad servers, helped publishers make their inventory available to advertisers, place ads in real time, and participate in auctions. These technologies had significant overlap and it was difficult to understand the differences between them. Now these facets of the business of publishing are unified under publisher ad servers.

153. Additionally, some publishers, especially those working at a large scale, used supply side platforms (SSPs) which allowed publishers to connect their inventory to large multiple exchanges, DSPs, or networks at once. They helped publishers sell inventory that might otherwise have gone unsold. By offering their inventory to the widest possible range of buyers, SSPs helped publishers maximize profits. Again, this distinction between SSPs and publisher tools has largely vanished in the current digital marketing ecosystem. Vendors that currently sell publisher ad server

technology include Google, OpenX, PubMatic, Rubicon Project, AppNexus, Right Media and AOL.[67]

154. Publisher inventory is perishable—once someone navigates away from a web page, those impressions are lost. Large publishers typically have a vast amount of this perishable inventory. Further down, I will go into detail about the implication of this perishable-but-plentiful inventory reality on the supply side. For now, we can note that when publishers possess large inventory, what they are offering to advertisers is not only space for ads, but space for ads that will appear in real time before consumers with specific traits.

155. As mentioned above, advertising is about placements, creatives and audiences, the where-what-who of advertising. Publishers provide the placement and the audience, while advertisers tend to provide the creative. Most impressions are provided by publishers who operate at a large scale, with millions or billions of impressions available every month, and so publishers often need scalable systems that can be used to help advertisers find the specific kinds of placements and audiences they want.

156. One of the services that publisher ad servers provide is inventory management. Publishers use inventory management systems to help them ensure that they satisfy the contractual obligations for the inventory they have sold. For example, ESPN may have sold Nike 30 million impressions in a given month. Nike will be dissatisfied if those impressions are clumped into just a couple of days, so ESPN must strive for even allocation of these impressions with about one million per day. For every individual impression, though, there may be dozens of advertisers who could have a claim on the impression based on the various types of targeted and untargeted deals ESPN struck. The inventory management system helps the publisher fulfill these obligations and minimize mistakes in publishing.

157. In addition to managing their inventory, publishers use publisher ad servers to execute the mechanical ad serving aspect of their business. This portion of the tech stack comprises specialized platforms that facilitate the delivery and management of advertisements on digital media properties such as websites and apps. These servers are responsible for determining which specific advertisements to display to users based on a variety of factors, including the advertiser's targeting criteria, the content of the website, and user data such as demographics and browsing history. Additionally, publisher ad servers track ad performance, providing vital metrics like impressions, clicks, and conversion rates to optimize ad placement and effectiveness.

158. One of the most widely used and comprehensive ad servers is Google's DoubleClick for Publishers (DFP). DFP emerged when Google bought the ad server

[67] Digiday. "WTF is a supply-side platform" (January 22, 2014). Accessed on June 4, 2024. https://digiday.com/media/wtf-supply-side-platform/.

D. Advertiser Ad Buying Tools

1. Overview

167. On the demand side, we have advertisers. Advertisers are typically playing a game that is a trade-off between the audience's size and quality. For example, imagine you are the investment bank Morgan Stanley trying to get people to put ten thousand dollars into a mutual fund. At the moment, there may only be a few hundred people in the United States who are prepared and inclined at the moment to invest ten thousand dollars in mutual funds. One option would be to run an advertising campaign that advertised broadly, hoping to find the few people prepared to invest that amount today. The cost of a campaign increases with the number of impressions, but even at high spend levels, a broad campaign may not reach this very specific subset of people. Another option would be to try to create an advertising campaign to target these specific people. That campaign would have a very small, but highly valuable audience. As a marketer, you might therefore be willing to pay a high price to advertise to that audience, with premiums far above the broad campaign to reach people ready to invest ten thousand dollars in a mutual fund.

168. Other smaller audiences that can be highly valuable include people who have already purchased from you, people who have something in a cart on your site, or people who meet certain criteria for your product—people who want to buy a new television, for example.

169. On the larger scale, larger audiences can be desirable and worth paying a high price for. In offline advertising, the classic example is the Super Bowl, which reaches most American households. In online advertising, a homepage takeover of a site like The Weather Channel, a top 10 worldwide site,[69] would be expensive but have tremendous reach to a broad audience.

170. In between these scales, we see the trade-offs that advertisers make in terms of size and audience quality. A tire company might purchase ads on the "road condition" portion of the site. A tire company that sells winter tires might purchase ads in this section during winter months north of the 40th parallel. If that company sold studded tires, they might further restrict their advertising to just states that permit studded tires. A promotion for a trade-in of a competitor's tire might be targeted even more narrowly. At every step, there is a trade-off between the size of an audience and the amount of information known about the audience.

171. Advertisers use tools to help plan, manage, and execute their marketing campaigns. The advertising ad buying tools helps an advertiser execute the basics of digital marketing: uploading and storing ad creatives, decision-making for which ads to serve based on bidding and targeting, and tracking the performance of ads (like

[69] Semrush Blog. "Top 100: The Most Visited Websites in the US [2024 Top Websites Edition]" (April 2024). Accessed on June 4, 2024. https://www.semrush.com/blog/most-visited-websites/.

clicks, impressions, conversions). Advertiser ad buying tools give advertisers control and visibility over their campaigns across multiple channels and publishers, allowing them to measure the effectiveness of their ads in real time.

172. On the demand side, advertisers often work with larger platforms to place ads at scale. As I have discussed above, today's marketers often place ads programmatically, which means that they also work with platforms that have built the infrastructure to purchase ad space inventory on a large scale.

173. The first demand side platforms (DSPs) emerged out of large advertising agencies who were buying large amounts of publisher inventory, on the order of billions of impressions per month, on behalf of many advertisers. Rather than having individual teams negotiating and purchasing inventory, sometimes resulting in teams negotiating against each other, the agencies formed the proto demand side platforms. Demand was aggregated at this level, allowing the entity to negotiate much better rates from the largest publishers.

174. DSPs are ad buying tools that allow advertisers to purchase ad inventory at a large scale in a system that is largely automated. There are three parts of buying ad inventory on DSPs. First, a marketer will develop a campaign and create advertising content, the ad creative. Next, the marketer will determine where the ad will be targeted and specify the spend or budget for the campaign. Third, the platform will search publisher inventory that meets the targeting criteria and can meet the budget. It then bids on the space for the ad, finalizes the bid, places the ad, and takes payment. Automation at so many stages of the marketing process reduces considerably the time advertisers take to place ads.

175. As the ad tech industry has evolved over time, many of the different tools that publishers and advertisers use to sell and serve ads have evolved, including ad servers on both the publisher and advertiser side, supply side platforms used by publishers, demand side platforms used by advertisers, ad buying tools, and even exchanges, which sometimes themselves bid in auctions, as though they are DSPs. Ultimately, it is most helpful to think of these tools as part of either buy side tools or sell side tools.

2. The Bifurcation of Tools for Large Advertisers and Small Advertisers

176. When it comes to tools for digital advertisers, the market has bifurcated into tools tailored specifically for large advertisers, such as DV360, and tools small advertisers, such as Google Ads. The customers for these tools have distinct needs and capabilities. Large advertisers typically operate at a scale that demands sophisticated tools capable of handling vast volumes of data and impressions. These advertisers often have dedicated internal teams and collaborate with external agencies to manage their marketing efforts. In fact, many large advertisers use different agencies

- Different access to inventory: in my experience, Google Ads provides much simpler access to YouTube than DV360.[77] Additionally, Google Ads is the primary way that most advertisers access the extensive Google Display Network.

E. Ad Exchanges

183. Ad exchanges are the place where advertisers and publishers come together to buy and sell ad inventory, in the form of impressions, in real-time auctions. Usually, to sell inventory in ad exchanges, publishers must meet a certain number of impressions. On advertising exchanges, advertisers place bids via DSPs and publishers make their inventory available for auction via SSPs.

184. While networks made it significantly easier for publishers to sell remnant inventory, the number of advertisers and publishers increased enough that by the mid-2000s, both advertisers and publishers, especially those buying and selling at scale, sought new technology to make serving ads even more streamlined.[78] Networks also had inefficiencies. There was a lack of price transparency, which translated to huge arbitrage opportunities for the networks. Furthermore, the lack of live bids left money on the table for publishers, while the uncertain delivery made it difficult for advertisers to make networks central to their buying strategies.

185. There are two main differences between ad networks and ad exchanges. The first is that ad networks are regarded as brokers for ads, while ad exchanges are open marketplaces, much like a stock exchange. The second difference is that ad exchanges are almost fully automated systems.

186. Right Media, founded in 2003, built the first ad exchange. It was revolutionary in that it allowed for real-time bidding, setting the foundation for what would become a significant shift in digital advertising.[79] Six years later, in 2009, Google launched it's the DoubleClick Ad Exchange. Google created this exchange, now called AdX, by sending the inventory from its two massive networks, AdSense and the DoubleClick's network, into the exchange.

187. [redacted],

[77] DV360, on the other hand, provides access to certain features that are only available via DV360. *See,* Google Marketing Platform. "Take control of your campaigns" (undated). Accessed on June 6, 2024. https://marketingplatform.google.com/about/display-video-360/. ("Google Preferred, YouTube Reserve and TrueView inventory are all available for you to buy in Display & Video 360.").
[78] AdButler. "Ad Networks vs Ad Exchanges: The History of Programmatic Advertising" (March 15, 2021). Accessed on June 3, 2024. https://www.adbutler.com/blog/article/ad-networks-vs-ad-exchanges-the-history-of-programmatic-advertising.
[79] Tech Crunch. "How Mike Walrath Built Right Media and Sold it for $850 Million" (April 12, 2011). Accessed on June 3, 2024. https://techcrunch.com/2011/04/12/founder-stories-right-media-walrath/.

Targeting bolstered its arsenal of advertising tools, particularly in the realm of local and retail advertising, extending its foothold in the retail advertising market.[120]

227. In February 2015, Google acquired Red Hot Labs, a California-based mobile gaming startup with an unconventional approach to mobile advertising and user acquisition. Specializing in user acquisition and growth hacking strategies, Red Hot Labs offered insights and expertise in mobile advertising optimization.[121] Google's acquisition of Red Hot Labs signaled its strategic focus on the mobile advertising market and its commitment to enhancing its mobile ad offerings. This acquisition positioned Google as a leader in the rapidly evolving mobile advertising landscape, driving innovation and growth in the mobile ad market.

228. In October 2016, Google acquired FameBit, a leading influencer marketing platform that facilitated collaborations between brands and digital creators on YouTube and other social media platforms. In Google's ongoing quest to redefine advertising paradigms, the acquisition of FameBit marked a strategic move into the realm of influencer marketing.[122]

1. Google's Ad Tech Tools and Platforms

229. Google's acquisitions over the past two decades reveal a strategic approach to buy tools in every facet of the ad tech ecosystem. By targeting key companies and technologies, Google has ensured its presence and influence across the entire digital advertising landscape.

230. The DoubleClick acquisition created Google's position in advertiser ad serving, publisher ad serving, and ad exchange technology. Before acquiring DoubleClick, Google was primarily a search publisher, with a side business in display via AdSense. The DoubleClick acquisition was a watershed moment in solidifying its control over publisher tools and SSPs. DoubleClick's ad management and serving solutions allowed Google to offer comprehensive ad delivery and optimization services to publishers. Additionally, the acquisition of AdMeld in 2011 allowed Google to offer advanced yield optimization and inventory management solutions. These acquisitions provided Google with unequaled capabilities to manage and optimize ad inventory from the publisher's perspective, making it a central player in the supply side of digital advertising.

---

[120] Tech Crunch. "Confirmed: Google Acquires Incentive Targeting to Power Super Targeted, Personalized Coupon Programs" (November 28, 2012). Accessed on June 4, 2024. https://techcrunch.com/2012/11/28/google-acquires-incentive-targeting-to-power-targeted-coupon-programs/.
[121] TechCrunch. "Google Acquires Facebook Marketing Startup Toro" (February 24, 2015). Accessed on June 6, 2024. https://techcrunch.com/2015/02/24/google-acquires-toro/.
[122] TechCrunch. "Google acquires FameBit to connect YouTube creators with marketers" (October 11, 2016). Accessed on June 6, 2024. https://techcrunch.com/2016/10/11/google-acquires-famebit-to-connect-youtube-creators-with-brands/.